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Labour demand and job-to-job movement

WOLTER HASSINK* and LOURENS BROERSMA§

*Department of Economics, Vrije Universiteit Amsterdam/Tinbergen Institute and

§Department of Economics, Vrije Universiteit Amsterdam

The relationship between labour demand and job-to-job movement is investigated, both theoretically and empirically, at the macro level. It concentrates on the role of the employment regime (hiring, do-nothing or firing) and the hiring and firing costs. The exact upper bounds of the marginal hiring costs of an employed worker are derived, for which job mobility between two firms yields a positive aggregate relationship between job-to-job movement and employment. The relationship is estimated as a cointegration model for the Netherlands; it appears that the inclusion of the job-to-job mobility rate may provide a substantial improvement of the estimated labour-demand equation.

I. INTRODUCTION

Although job-to-job mobility may facilitate employment adjustment, the impact of job-to-job movement has never been fully implemented into labour-demand models. In this paper, job-to-job mobility is a worker's change of jobs between different firms. In labour-demand literature the outflow part of job-to-job movement, voluntary quits, is captured, mainly in theoretical studies (Nickell, 1986 and Bertola, 1992), but recently also in some empirical studies (Burgess, 1993, Hamermesh, 1995, and Hamermesh and Pfann, 1996). For the inflow part of job-to-job movement a distinction between different sources of applicants is necessary, but so far this topic has not been discussed in labour-demand studies.

The purpose of this paper is to derive the conditions under which job-to-job movement has a positive impact on the level of employment, and to estimate the relationship. Job-to-job mobility is a very complex phenomenon because it involves matches of heterogeneous workers with heterogeneous firms. Our paper concentrates on the role of the employment regime (hiring, do-nothing or firing) and the hiring and firing costs. Our model is very simplified: firms have equal technologies, although they may be in different employment regimes (firing, do-nothing or hiring) and they have different hiring costs. Quits of workers to other firms are considered as an exogenous process. We do not consider the impact of efficient wages (Stiglitz, 1986).

The plan of this paper is as follows. Section II provides the theoretical micro-model; Section III considers its macro-implications; Section IV discusses some tentative estimation results; Section V concludes.

II. THEORY

This section constructs a micro-framework describing the relationship between employment and job-to-job mobility. To determine the optimal employment path, firm i maximizes the expected discounted future profits

$$\max_{\{L_{i,t+s}\}} E_t \sum_{s=0}^{\infty} \phi^s \left[\Pi(L_{i,t+s}, Z_{1,i,t+s}, Z_{2,i,t+s}, \dots, Z_{R,i,t+s}) - w_{i,t+s} L_{i,t+s} - \sum_{r=1}^R p_{r,i} Z_{r,i,t} - 0.5 C_{i,t+s} \right] \quad i = 1, \dots, N \quad (1)$$

where E_t is the expectations operator conditional on the information available at time t , ϕ is discount factor, Π is a concave production function, L is the level of employment, which is homogeneous inside a firm, Z are other production factors, w is the real wage, p_r is the real price of the r th production factor, $R + 1$ is the number of production factors, N the number of firms, and C is an adjustment cost function.

Following Hamermesh (1995), our functional form of the production function is

$$\begin{aligned} \Pi(L_{i,t}, Z_{1,i,t}, Z_{2,i,t}, \dots, Z_{R,i,t}) \\ = (\bar{\xi}_0 + \xi_{0,i,t})L_{i,t} + \sum_{r=1}^R (\bar{\xi}_r + \xi_{r,i,t})Z_{r,i,t} - 0.5\psi_0 L_{i,t}^2 \\ - 0.5 \sum_{r=1}^R \psi_r Z_{r,i,t}^2 + \sum_{r=1}^R \zeta_r L_{i,t} Z_{r,i,t}, \\ i = 1, \dots, N \end{aligned} \quad (2)$$

where $\bar{\xi}$, ζ and ψ are positive parameters of the production function; ξ is a serially uncorrelated error process, with zero mean and finite variance.

The adjustment costs C are split into net and gross adjustment costs, because Hamermesh (1995) demonstrates empirically that both sources of turnover costs are present. Net adjustment costs are the costs of a change of the long-run levels of employment. Gross adjustment costs are the costs of the total inflow of workers, which are, for instance, the costs of selection and training, or the costs of the total outflow of workers, which are the costs of firing. We distinguish between the hiring of previously unemployed and employed workers, having marginal gross adjustment costs $2v_{1,i}F^{iu}$ and $2v_2F^{iq}$, respectively. The former are heterogeneous across firms. The difference is caused by heterogeneous training costs, but we assume that after training the workers inside the firm are homogeneous.

The model is based on three additional simplifying assumptions. The first simplifying assumption is that there are different employment regimes: a 'hiring regime' in which the firm only hires; a 'do-nothing regime', in which the firm neither hires nor fires; and a 'firing regime', in which the firm only fires. This framework implies that a firm does not hire and fire simultaneously. Note that this framework is only suitable for labour that is homogeneous inside firms. Obviously, this is not very realistic. Hamermesh *et al.* (1996) demonstrated that due to heterogeneous labour a lot of firms hire and fire simultaneously. The second assumption is that both the type of applicants and the quit decision of the worker are exogenous for a firm. The third assumption is that we assume that a firm does not form a pool of applicants, but hires the first suitable applicant, whether previously employed or unemployed. Hence, it is possible that a firm hires previously unemployed and employed workers within the same period.

The adjustment cost functions of firm i for the three regimes are, respectively,

$$C_{i,t} = v_0(L_{i,t} - L_{i,t-1})^2 + v_{1,i}(F_{i,t}^{iu})^2 + v_2(F_{i,t}^{iq})^2 \quad (3a)$$

if $L_{i,t} = L_{i,t-1} + F_{i,t}^{iq} + F_{i,t}^{iu} - F_{i,t}^{xq}$

$$C_{i,t} = v_0(L_{i,t} - L_{i,t-1})^2 \quad \text{if } L_{i,t} = L_{i,t-1} - F_{i,t}^{xq} \quad (3b)$$

$$C_{i,t} = v_0(L_{i,t} - L_{i,t-1})^2 + v_3(F_{i,t}^{xu})^2 \quad (3c)$$

if $L_{i,t} = L_{i,t-1} - F_{i,t}^{xu} - F_{i,t}^{xq}$

F represents various workers flows; the superscripts iq and iu denote the inflow of employed and unemployed workers, respectively; the superscripts xq and xu denote the outflow of a worker to another job or into unemployment, respectively; v_0 , $v_{1,i}$, v_2 and v_3 are positive parameters.

The marginal gross firing costs are $2v_3F^{xu}$. In a firing regime no gross adjustment costs are connected to a voluntary outflow F^{xq} , since, with homogeneous labour, quits contribute to the reduction of employment, which a firm in a firing regime wants to attain. In a firing regime the number of quits may be larger than the planned decrease of the level of employment, which leads, consequently, to hiring of workers. We abstract from this case, because it does not provide additional knowledge about job mobility. Net adjustment costs are the same for all regimes. However, Equation 3 reflects an asymmetric relationship between quits and adjustment costs. In a hiring regime a voluntary outflow of workers may increase the adjustment costs. On the other hand, in a firing regime such an outflow of workers decreases the adjustment costs, as can readily be observed from Equation 3c.

Appendix A derives the labour demand equations for the three regimes. The labour demand equation for a firm in a hiring regime is

$$\begin{aligned} L_{i,t} &= \alpha_i L_{i,t-1} + (\eta_i v_{1,i} - \eta_i v_2) F_{i,t}^{iq} - \eta_i v_{1,i} F_{i,t}^{xq} \\ &+ \sum_{r=0}^R \gamma_r Z_{r,i,t}, \\ F_{i,t}^{iq} + F_{i,t}^{iu} &> 0 \end{aligned} \quad (4a)$$

where α and γ are parameters, and $w \equiv Z_0$. The parameter η_i is equal to

$$\alpha_i(1 - \rho_{iq}/\beta_i)^{-1}(\phi\rho_{iq} - 1)/(v_0 + v_{1,i})$$

where ρ_{iq} is the AR-parameter of the AR(1)-process, that we assume to generate voluntary quits; α_i and β_i are the smallest and the largest root of the second order difference equation in $L_{i,t}$ (Appendix A); $(1 - \alpha_i)$ is called the speed of adjustment of employment. Conditional on the inflow of a previously unemployed worker, the negative impact of voluntary quits on employment equals $\eta_i v_{1,i} F^{xq}$. If also employed workers have been hired, the impact of the inflow of employed workers on L is $(\eta_i v_{1,i} - \eta_i v_2) F^{iq}$. Equation 4a shows that if the hiring costs of a previous employed worker are lower (higher) than the hiring costs of a previously unemployed worker, the inflow of previously employed workers has a positive (negative) impact on employment.

In the same way, it is possible to derive the labour demand equations for a firm in a do-nothing regime and a firing regime. These are, respectively,

$$\begin{aligned} L_{i,t} &= \alpha_0 L_{i,t-1} + \sum_{r=0}^R \gamma_r Z_{r,i,t} \\ L_{i,t} &= L_{i,t-1} - F_{i,t}^{xq} \end{aligned} \quad (4b)$$

and

$$L_{i,t} = \alpha_i L_{i,t-1} - \eta_i v_3 F_{i,t}^{xq} + \sum_{r=0}^R \gamma_{r,i} Z_{r,i,t} \quad (4c)$$

$$F_{i,t}^{xu} > 0$$

Equation 4c shows that in a firing regime, higher firing costs, v_3 , lead to a more negative impact of quits on employment. Thus, if firing costs are low, quits have less impact on employment than if firing costs are high. In the extreme case of absence of firing costs ($v_3 = 0$), a quit has no impact on employment, since the firm faces two options to reduce employment, voluntary quits or firing, which both have no gross adjustment costs.

III. MACRO IMPLICATIONS

This section considers the implications of the micro-equations for labour demand at the macro-level. To keep things simple, we first discuss two cases in which one worker moves from one firm to another. In both cases, the worker moves to a firm in a hiring regime. The firm from which the worker quits is, in the first case, also in a hiring regime, but in the second case it is in a firing regime. Next, we construct the aggregate equation for all firms. We do not explicitly discuss job-to-job movement from a firm in a do-nothing regime, since, if we take $v_3 = 0$, then a voluntary quit from a firing firm and a do-nothing firm have the same implications.

Labour mobility from a hiring firm to another hiring firm

Suppose that both firm i and firm j want to hire one extra worker. We first investigate for which values of $v_{1,i}$, $v_{1,j}$ and v_2 , the marginal gross adjustment costs in the case of absence of a quit between firm i and j are larger than the marginal gross adjustment costs in the case of a quit between firm i and j . Only then, can job-to-job movement have a positive impact on the level of employment. Next, we compare this outcome with the coefficient of job-to-job movement in the aggregate employment equation.

If there is no movement of a worker between firm i and j , then both firms hire an unemployed worker. According to Equation 3a, the marginal gross adjustment costs without a quit are $2v_{1,i} + 2v_{1,j}$. In the case of a job switch from firm j to firm i , firm i hires the employed worker from firm j , and firm j hires two unemployed workers, since both firms want to expand employment with one person each. The marginal gross adjustment costs become $2v_2 + 4v_{1,j}$. Job-to-job movement has a positive impact on employment only if the marginal gross adjustment costs, in the case of absence of job mobility between both firms, are larger than the marginal gross adjustment costs in the case of a worker moving

between both firms. Hence,

$$2v_{1,i} + 2v_{1,j} > 2v_2 + 4v_{1,j}$$

or,

$$v_{1,i} - v_{1,j} > v_2 \quad (5)$$

Thus, job-to-job mobility will increase employment at the aggregate level if the marginal gross adjustment costs of hiring an unemployed worker are much lower (at least v_2) for firm j than for firm i . Note that if both firm i and firm j have the same marginal gross adjustment costs of hiring an unemployed, then the LHS of Equation 5 is zero. In that case both firms lose when a worker moves from one firm to the other, because in total it leads to higher marginal gross adjustment costs. This is the case, even if the marginal gross adjustment costs of a quit ($2v_2$) are relatively low.

We compare Equation 5 with the coefficient of job-to-job mobility in an aggregate labour-demand equation. Concentrating on the inflow and outflow of workers, the labour-demand equations of firm i and j are, essentially,

$$L_{i,t} = \eta_i v_{1,i} F_{i,t}^{iq} - \eta_i v_2 F_{i,t}^{iq} - \eta_i v_{1,i} F_{i,t}^{xq} + \dots \quad (6a)$$

$$L_{j,t} = \eta_j v_{1,j} F_{j,t}^{iq} - \eta_j v_2 F_{j,t}^{iq} - \eta_j v_{1,j} F_{j,t}^{xq} + \dots \quad (6b)$$

where the dots represent the other explanatory variables which have been omitted for convenience. Suppose there is one quit from firm j to firm i , hence $F_{i,t}^{iq} = F_{j,t}^{xq} = 1$ and $F_{i,t}^{xq} = F_{j,t}^{iq} = 0$. The aggregate labour-demand equation of both firms becomes

$$L_t = (\eta_i v_{1,i} - \eta_i v_2 - \eta_j v_{1,j}) JJ_t + \dots, \quad (7)$$

where job-to-job movement $JJ = F_t^{iq} = F_t^{xq}$. Quits have a positive impact on the level of employment if the coefficient of job-to-job mobility is positive, or

$$v_{1,i} - (\eta_j/\eta_i) v_{1,j} > v_2 \quad (8)$$

This is almost equal to Equation 5, except for a scaling factor η_j/η_i . According to Appendix A,

$$\begin{aligned} \eta_j/\eta_i &= [(v_0 + v_{1,i})/(v_0 + v_{1,j})][(\beta_i - \rho_{iq})/(\beta_j - \rho_{iq})] \\ &\quad \times [(\alpha_j \beta_j / \alpha_i \beta_i)] \\ &\approx (\alpha_j v_{1,i})/(\alpha_i v_{1,j}) \geq 1, \text{ if } v_{1,j} \leq v_{1,i} \\ &< 1, \text{ if } v_{1,j} > v_{1,i} \end{aligned} \quad (9)$$

Recall that $(1 - \alpha_i)$ is the speed of adjustment of employment of firm i . From Equations A3 and A4 in Appendix A one can derive that $v_{1,j} < v_{1,i}$ implies $\alpha_j > \alpha_i$. This is also intuitively clear, since larger gross adjustment costs of the inflow of unemployed workers leads to a slower speed of adjustment of employment. η_i is determined by ϕ , ψ_0 , v_0 and $v_{1,i}$; the exact relationship is very complex. We

have simulated η_j/η_i for different values $v_{1,i}$ and $v_{1,j}$, using several realistic values of ϕ , ψ_0 and v_0 , based on estimates of Sargent (1978) and Meese (1980). It appears that ratio η_j/η_i is slightly larger than one, and varies only moderately. Simulation results are available from the authors upon request.

Equations 6a,b also imply that if firm i and j hire one worker from each other, the coefficient of JJ becomes $-(\eta_i + \eta_j)v_2$. Hence, job-to-job mobility has a negative impact on aggregate employment, if two firms exchange a worker.

Labour mobility from a firing firm to a hiring firm

The second case concerns job-to-job mobility from a firm in a firing regime to a firm in a hiring regime. Again, we first investigate the effect of job-to-job mobility on the gross adjustment costs for both firms. Recall that a reduction of gross adjustment costs of employment has a negative impact on employment for the firing firm, but a positive impact on employment for the hiring firm. Therefore, in order to obtain a positive relationship between aggregate employment and aggregate quits, the firm in the hiring regime should have relatively low gross adjustment costs, whereas the firm in the firing regime should have high gross adjustment costs. Hence, in this case, we may not compare the situation without quits with the situation with quits, such as in Equation 5. Instead, we compare the *reduction* of the marginal gross adjustment costs for the firing firm due to a quit instead of firing a worker, with the *reduction* of the marginal gross adjustment costs for the hiring firm, due to hiring an employed worker instead of an unemployed. If the former is smaller than the latter, job-to-job mobility has a positive impact on the aggregate level of employment.

Suppose firm i hires an unemployed worker, with marginal gross adjustment costs $2v_{1,i}$, and firm j fires an employed worker, with marginal gross adjustment costs $2v_3$. Quits have a positive impact on employment for both firms taken together, only if the decrease of the marginal gross adjustment costs of the hiring firm ($2v_{1,i} - 2v_2$) is larger than the decrease of the marginal gross adjustment costs, ($2v_3 - 0$) (no costs are connected with a quit), of the firing firm:

$$v_{1,i} - v_2 > v_3 \quad (10)$$

Next, we compare this result with the coefficient of job-to-job mobility in the aggregate labour-demand equation of both firms. The labour-demand equation of firms i and j are

$$L_{i,t} = \eta_i v_{1,i} F_{i,t}^{iq} - \eta_i v_2 F_{i,t}^{iq} - \eta_i v_{1,i} F_{i,t}^{xq} + \dots \quad (11a)$$

$$L_{j,t} = -\eta_j v_3 F_{j,t}^{xq} + \dots \quad (11b)$$

Since, $F_{i,t}^{iq} = F_{j,t}^{xq} = 1$ and $F_{i,t}^{xq} = 0$, the aggregate equation of both firms becomes

$$L_t = (\eta_i v_{1,i} - \eta_i v_2 - \eta_j v_3) JJ_t + \dots \quad (12)$$

Job-to-job mobility has a positive impact on employment at the aggregate level, if

$$v_{1,i} - v_2 > (\eta_j/\eta_i) v_3$$

Simulations have shown that η_j/η_i is about equal to one.

The aggregate equation

The two previous sub-sections have demonstrated under which restrictions a quit between two firms leads to a positive impact on the level of employment. Job-to-job movement can be considered as an allocation process, which changes the adjustment costs overall. It is possible that job-to-job mobility between two firms is not an optimal allocation process, for instance, if $v_{1,i}$ and $v_{1,j}$ do not differ sufficiently for two firms in a hiring regime, and yet an employee changes jobs. The labour-demand equation at the macro level becomes

$$L_t = \lambda L_{t-1} + \sum_{r=0}^R \gamma_r Z_{r,t} + \gamma_{R+1} JJ_t \quad (13)$$

where the coefficients are weighted sums of the coefficients of the individual labour-demand equations. The sign of γ_{R+1} is indeterminate.

IV. EMPIRICAL RESULTS

This section presents the estimation and test results of Equation 13. Ideally, one should use a data set of firms containing information on the hiring costs from different sources of workers. Because we have no access to such a data set, we use quarterly manufacturing data for the Netherlands as a first step. We take as explanatory variables in the vector Z : the real wage (w), the real capital stock (K), measures of competitiveness ($COMP$), world trade shocks (WT) and adjusted fiscal stance (AD) and an index of technical progress (TP). Appendix B provides a description of these variables.

Notice that the aggregate labour-demand Equation 13 is based on aggregation across firms with heterogeneous, firm-specific labour, with different responses. Therefore, we specify a functional form with additional lags on all variables in Equation 13 (cf. Nickell, 1986). Application of the augmented Dickey–Fuller unit root test indicates that the presence of a unit root in all variables involved, with a possible exception of WT , cannot be denied. Hence, if the error process is stationary, we can rewrite Equation 13 in

error-correction form

$$\begin{aligned} \Delta_1 \log(L_t) = & \mu + \lambda_1(\log(L_{t-1}) + \sum_{r=0}^R \gamma_r \log(Z_{r,t-1}) \\ & + \gamma_{R+1} JJ_{t-1}) + \sum_{s=1}^p \tau_s \Delta_1 \log(L_{t-s}) \\ & + \sum_{r=0}^R \sum_{s=1}^q \tau_{r,s} \Delta_1 \log(Z_{r,t-s}) \\ & + \sum_{s=1}^q \tau_{R+1,s} \Delta_1 JJ_{t-s} + \varepsilon_t \end{aligned} \quad (14)$$

where μ is the deterministic part of the equation, consisting of a constant and seasonal dummy variables, Δ is the difference operator $\Delta_k X \equiv X_t - X_{t-k}$ and ε_t is an uncorrelated white-noise error process. All explanatory variables in Equation 14 are lagged in order to evade simultaneity bias of the estimates of the parameters.

Our approach to model specification is to move from general to specific. Also the standard battery of misspecification tests will be applied in order to assess the statistical validity of the model involved. As tests on cointegration we apply the Wald test developed by Boswijk (1992) and the standard tests of Engle and Granger (1987). Both indicate that cointegration, as assumed to be present in Equation 14, cannot be rejected. Results of unit root, simplification and cointegration tests can be obtained from the authors on request. The simplified model that is finally selected, is presented in Table 1.

This model has the following implications. First, the short-run demand elasticity including scale effects, based on Hamermesh (1993), which can be obtained from the error-correction part of the model, is -0.32 . This is very much in line with the survey of empirical studies from Hamermesh (1993) who argues that the elasticity should be about -0.30 . The coefficients of $\Delta_1 COMP_{t-1}$ and $\Delta_1 W T_{t-1}$ have the expected sign. The negative sign of the capital stock variable implies substitution between labour and capital. The coefficient of the JJ_{t-1} is positive, implying that an increase in the job-to-job mobility rate contributes to expanding employment. The elasticity with respect to job-to-job movement is about 0.23.

In Equations 4a and 4c, we introduced the possibility of a different effect of quits on employment, depending on the assumption of whether the firm is in a hiring regime or in a firing regime. However, the estimates of Table 1 imply a constant impact. We next try to relax this assumption by weighting the quits over the number of firms in a hiring and a firing regime. The weights applied are based on the flow of persons into and out of employment. Outflow F^x equals the total number of persons moving from employment into unemployment and non-participation in the Netherlands. Then inflow F^i is defined as $F_t^i = \Delta_1 L_t^{\text{tot}} + F_t^x$, where L^{tot} is

Table 1. Estimation results

Dependent variable: $\Delta_1 \log L_t$ Sample period: 1972:2–1990:4	
Independent variables	
CONST	− 0.0030 (− 3.686)*
$\log(L/K)_{t-1}$	− 0.0049 (− 4.435)*
$\log(w_{t-1})$	− 0.0016 (− 2.426)*
JJ_{t-1}	0.0011 (4.368)*
$\Delta_1 \log L_{t-1}$	1.1466 (39.92)*
$\Delta_1 \log L_{t-4}$	− 0.2896 (− 8.220)*
$\Delta_4 \log(K_{t-1})$	− 0.0186 (− 4.959)*
$\Delta_1 \log(w_{t-1})$	− 0.0174 (− 2.653)*
$\Delta_1 COMP_{t-1}$	0.0038 (2.155)*
$\Delta_1 W T_{t-1}$	0.0181 (4.654)*
S.E.	0.000751
R^2	0.986
T	75
$\chi^2_{\text{norm}}(2)$	2.163
$F_{\text{AR}}(1, 61)$	0.426
$F_{\text{AR}}(5, 57)$	0.135
LB (12)	14.02
$F_{\text{ARCH}}(1, 74)$	0.947
$F_{\text{ARCH}}(5, 70)$	0.738
$F_{\text{RESET}}(1, 61)$	0.840
$F_{\text{RESET}}(3, 59)$	1.481
$F_{\text{Chow}}(16, 46)$	0.986
$F_{\text{Chow}}(8, 54)$	0.690
$F_{\text{Xi}^2}(22, 53)$	1.503

* Statistically significant from zero at the 5% level.

Seasonal dummies are not presented. The t -values are in brackets by the estimated parameter values, S.E. is the residual standard error of the equation, R^2 is the correlation coefficient and T is the number of observations used to estimate and test the model, χ^2_{norm} is the normality test of Jarque and Bera. F_{AR} is Godfrey's test on residual autocorrelation. LB is the Ljung–Box test on residual autocorrelation. F_{ARCH} is Engle's ARCH test on heteroskedasticity. F_{RESET} is the RESET test. F_{Chow} is the Chow test on predictive failure and F_{Xi^2} is White's test on heteroskedasticity, based on actual and squared regressors. The numbers in brackets by the test statistics represent the corresponding degrees of freedom.

the total number of workers in the Netherlands. Total mobility from firms in a firing regime to firms in a hiring regime is approximated by

$$JJf_t = JJ_t^* F_t^x / (F_t^x + F_t^i)$$

then mobility from firms in a hiring regime to other firms in a hiring regime is

$$JJh_t = JJ_t^* F_t^i / (F_t^x + F_t^i)$$

This approach yields the model presented in Table 2. Like the model in Table 1, none of the diagnostic tests seem to indicate that it is severely misspecified.

The estimation results of this extended model show that the coefficients of the explanatory variables are of a similar magnitude as those of the model in the Table 1. In this case, we find a wage elasticity with scale effect of -0.27 . The distinction we make between quits in a hiring and in a firing regime, seems to suggest that only quits in a firing regime

Table 2. Estimation results

Dependent variable: $\Delta_1 \log L_t$		Sample period: 1972:2–1990:4
Independent variables		
$CONST$	– 0.0028 (– 3.430)*	– 0.0029 (– 3.899)*
$\log(L/K)_{t-1}$	– 0.0046 (– 4.106)*	– 0.0047 (– 4.550)*
$\log(w_{t-1})$	– 0.0012 (– 1.759)*	– 0.0013 (– 1.957)*
JJh_{t-1}	– 0.0002 (– 0.243)	
JJf_{t-1}	0.0026 (2.547)*	0.0024 (4.685)*
$\Delta_1 \log L_{t-1}$	1.1744 (34.50)*	1.1698 (41.90)*
$\Delta_1 \log L_{t-4}$	– 0.2911 (– 8.342)*	– 0.2920 (– 8.474)*
$\Delta_4 \log(K_{t-1})$	– 0.0184 (– 4.928)*	– 0.0185 (– 5.092)*
$\Delta_1 \log(w_{t-1})$	– 0.0202 (– 2.988)*	– 0.0197 (– 3.057)*
$\Delta_1 COMP_{t-1}$	0.0038 (2.150)*	0.0038 (2.170)*
$\Delta_1 WT_{t-1}$	0.0188 (4.106)*	0.0187 (4.883)*
S.E.	0.000744	0.000739
R ²	0.986	0.986
T	75	75
$\chi^2_{\text{form}}(2)$	2.879	2.656
F _{AR} (1, 61)	0.221	0.226
F _{AR} (5, 57)	0.169	0.163
LB(12)	14.84	14.76
F _{ARCH} (1,74)	0.470	0.558
F _{ARCH} (5,70)	0.259	0.318
F _{RESET} (1,61)	0.829	0.824
F _{RESET} (3,59)	1.552	0.975
F _{Chow} (16,45)	0.950	0.807
F _{Chow} (8,53)	0.888	0.753
F _{Xi2} (22,53)	1.429	1.414

* Statistically significant from zero at the 5% level.
Statistical parameters as Table 1.

have a positive and significant impact on employment, whereas the influence of quits in a hiring regime appears to be negative and insignificantly different from zero. Hence, the effect of job-to-job mobility on employment is larger in case a majority of firms is in a firing regime. The elasticity with respect to *JJf* equals 0.51.

Turning back to the theory of Sections II and III, we can draw the following tentative conclusions from our empirical results. First, job-to-job mobility appears to have a significant positive impact on employment. Second, in distinguishing hiring and firing regimes, it appears that the impact of job-to-job mobility on employment is significantly different between those regimes. This suggests that there is considerable heterogeneity between firms, which is also implied by our theory. Job mobility from a firm in a firing regime to a hiring firm appears to have a particularly strong, positive effect on employment. According to Equation 12 the positive sign of *JJf* indicates that the benefits for the firm with increasing employment, i.e. hiring an employed worker instead of an unemployed, are larger than the benefits for the firm with decreasing employment, i.e. not having to fire the worker. This might indicate that for a lot of firms the hiring costs of employed workers are smaller than the hiring costs of unemployed workers, which is in accordance with Blau and Robins (1990) and Lindeboom *et al.* (1993). In the case

of job mobility from a firm in a hiring regime to a hiring firm, *JJh* has a negative yet insignificant effect on employment. Equation 7 shows that the non-positive sign of *JJh* implies a weak heterogeneity concerning inflow costs of unemployed workers across firms. In that case job mobility between two firms in a hiring regime is not beneficial for both firms.

V. CONCLUSIONS

In this paper we have demonstrated theoretically under which conditions labour mobility between two firms has a positive impact on the aggregate level of employment. We have derived the upper bound of the marginal hiring costs of an employed worker, for which job-to-job movement has a positive impact on aggregate employment. We have distinguished two cases. In the first case, a worker moves from a firm in a hiring regime to another firm in a hiring regime. Job-to-job movement increases the gross adjustment costs of the firm from which the employee leaves, but may reduce the inflow costs for the firm to which the employee moves. We have demonstrated that for those pairs of firms, job-to-job mobility has a positive impact on aggregate employment if the *difference* in marginal adjustment costs of hiring an unemployed worker between both firms is larger than the marginal hiring costs of an employed worker. In the second case, a worker moves from a firm in a firing regime to a firm in a hiring regime. This movement leads to a reduction of gross adjustment costs for both firms. In this case, job-to-job movement has a positive impact on employment if the *reduction* of the marginal gross adjustment costs for the firm in the hiring regime is larger than the *reduction* for the firm in the firing regime. We conclude that it is not possible to establish the sign of job-to-job movement in the aggregate employment equation *a priori*, unless the size of the inflow costs of employed and unemployed workers of both firms is known. This is in line with Caballero (1992), who argues that aggregation may lead to indeterminate relationships.

The heterogeneity of the inflow costs of unemployed workers over firms is an important element of the theoretical framework. Therefore, the relationship between quits and employment should ideally be tested with micro-data, containing at least information on the source and the costs of the inflow of workers. We have estimated the relationship with macro-data for the Netherlands. It appears that job-to-job mobility has a substantial positive impact on employment, implying that job mobility is beneficial for the demand for labour. From a policy point of view it indicates that to stimulate employment growth it is important to promote job mobility of workers. For instance the government should ensure that a job change does not reduce the pension claim of a worker (this still may happen in the Netherlands). Basically, this is in accordance with measures to stimulate a more flexible labour market.

In our empirical model we have made an effort to distinguish quits from firms in a firing regime to firms in a hiring regime, and quits from firms in a hiring regime to other firms in a hiring regime. The former variable has a positive coefficient, indicating that the reduction in training costs for the hiring firm is larger than the reduction in firing costs for the firm with decreasing employment. This estimate indicates that the hiring costs of an unemployed may be larger than the hiring costs of an employed worker. The latter variable has a insignificant, negative, coefficient, which leads to the conclusion that the heterogeneity in inflow costs of unemployed workers is not so large that job mobility between two hiring firms facilitates aggregate employment adjustment.

APPENDIX A. MICRO LABOUR-DEMAND EQUATIONS

For its employment decision, the maximization problem of firm i in a hiring regime is

$$\begin{aligned} \max_{\{L_{i,t+s}\}} E_t \sum_{s=0}^{\infty} \phi^s \{ & \Pi(L_{i,t+s}, Z_{1,i,t+s}, Z_{2,i,t+s}, \dots, Z_{R,i,t+s}) \\ & - w_{i,t+s} L_{i,t+s} - \sum_{r=1}^R p_{r,i} Z_{r,i,t+s} \\ & - 0.5[v_0(L_{i,t+s} - L_{i,t+s-1})^2 + v_{1,i}(F_{i,t+s}^{i0})^2 \\ & + v_{2,i}(F_{i,t+s}^{iq})^2] \} \end{aligned} \quad (A1)$$

Using the definition of Π in Equation 2, this is equal to

$$\begin{aligned} \max_{\{L_{i,t+s}\}} E_t \sum_{s=0}^{\infty} \phi^s \{ & (\bar{\xi}_0 + \xi_{0,t+s}) L_{i,t+s} + \sum_{r=1}^R (\bar{\xi}_r + \xi_{r,t+s}) Z_{r,i,t+s} \\ & - 0.5\psi_0 L_{i,t+s}^2 - 0.5 \sum_{r=1}^R \psi_r Z_{r,i,t+s}^2 \\ & + \sum_{r=1}^R \zeta_r L_{i,t+s} Z_{r,i,t+s} - w_{i,t+s} L_{i,t+s} - \sum_{r=1}^R p_{r,i} Z_{r,i,t+s} \\ & - 0.5[v_0(L_{i,t+s} - L_{i,t+s-1})^2 + v_{1,i}(L_{i,t+s} - L_{i,t+s-1} \\ & - F_{i,t+s}^{iq} + F_{i,t+s}^{xq})^2 + v_{2,i}(F_{i,t+s}^{iq})^2] \} \end{aligned} \quad (A2)$$

The Euler equation of Equation A2 is

$$\begin{aligned} \phi E_{t+s} L_{i,t+s+1} - [\psi_0/(v_0 + v_{1,i}) + 1 + \phi] L_{i,t+s} + L_{i,t+s-1} \\ = (v_0 + v_{1,i})^{-1} [- (\bar{\xi}_0 + \xi_{0,t+s}) + w_{i,t+s} - \sum_{r=1}^R \zeta_r Z_{r,i,t+s} \\ + (v_{1,i} - v_2)(\phi E_{t+s} F_{i,t+s+1}^{iq} - F_{i,t+s}^{iq}) \\ - v_{1,i}(\phi E_{t+s} F_{i,t+s+1}^{xq} - F_{i,t+s}^{xq})] \\ s = 0, 1, 2, \dots \end{aligned} \quad (A3)$$

where the transversality condition is

$$\lim_{s \rightarrow \infty} \phi^s E_t L_{t+s} = 0$$

We follow Sargent (1978) and Hamermesh (1995) by modeling forward-looking expectations. The solutions of the Euler equation, after factorisation, is

$$\begin{aligned} L_{i,t} = & \alpha_i L_{i,t-1} - \alpha_i / (v_0 + v_{1,i}) \sum_{s=0}^{\infty} \beta_i^{-s} [- (\bar{\xi}_0 + \xi_{0,t+s}) \\ & + w_{i,t+s} - \sum_{r=1}^R \zeta_r Z_{r,i,t+s} \\ & + (v_{1,i} - v_2)(\phi E_{t+s} F_{i,t+s+1}^{iq} - F_{i,t+s}^{iq}) \\ & - v_{1,i}(\phi E_{t+s} F_{i,t+s+1}^{xq} - F_{i,t+s}^{xq})] \end{aligned} \quad (A4)$$

where $0 < \alpha_i < 1 < \phi^{-1} < \beta_i$. Note that the roots of the second-order difference Equation A3, α_i and β_i are nonlinear functions of ϕ , ψ_0 , v_0 and $v_{1,i}$. We assume $\xi_{0,i,t}$, $F_{i,t}^{xq}$, $F_{i,t}^{iq}$, $w_{i,t}$ and $Z_{r,i,t}$, $r = 1, \dots, R$, to follow an AR(1)-process, with AR parameters ρ_{ϕ} , ρ_{xq} , ρ_{iq} , ρ_w and $\rho_{Z,r}$, $r = 1, \dots, R$, respectively (cf. Sargent, 1978 and Hamermesh, 1995). The labour-demand equation becomes

$$\begin{aligned} L_{i,t} = & \alpha_i L_{i,t-1} - \alpha_i / (v_0 + v_{1,i}) [- \bar{\xi}_0 (1 - 1/\beta_i)^{-1} \\ & - \xi_{0,t} (1 - \rho_{\xi})^{-1} + w_{i,t} (1 - \rho_w/\beta_i)^{-1} \\ & - \sum_{r=1}^R \zeta_r Z_{r,i,t} (1 - \rho_{Z,r}/\beta_i)^{-1} \\ & + (v_{1,i} - v_2) (1 - \rho_{iq}/\beta_i)^{-1} (\phi \rho_{iq} - 1) F_{i,t}^{iq} \\ & - v_{1,i} (1 - \rho_{xq}/\beta_i)^{-1} (\phi \rho_{xq} - 1) F_{i,t}^{xq}] \end{aligned} \quad (A5)$$

We define $w \equiv Z_0$, and suppose $\rho_{iq} \approx \rho_{xq}$. Equation A5 becomes in obvious notation

$$\begin{aligned} L_{i,t} = & \alpha_i L_{i,t-1} + \eta_i v_{1,i} F_{i,t}^{iq} - \eta_i v_2 F_{i,t}^{iq} - \eta_i v_{1,i} F_{i,t}^{xq} \\ & + \sum_{r=1}^R \gamma_{r,i} Z_{r,i,t}, \\ & F_{i,t}^{iq} + F_{i,t}^{xq} > 0 \end{aligned} \quad (A6)$$

where $\eta_i = \alpha_i (1 - \rho_{iq}/\beta_i)^{-1} (\phi \rho_{iq} - 1) / (v_0 + v_{1,i})$.

In the same way, the labour demand in the do-nothing regime and the firing regime can be derived.

APPENDIX B. DATA SOURCES, DEFINITIONS AND ABBREVIATIONS

Abbreviations

CBS	Netherlands Central Bureau of Statistics
CPB	Netherlands Central Planning Bureau
OECD	Organization of Economic Cooperation and Development

UN	United Nations
MEI	Main Economic Indicators
MBS	Monthly Bulletin of Statistics
NA	National Accounts

All variables are based on those used by Layard and Nickell (1986) and Burgess (1993). Interpolation is done by means of a third order polynomial function, unless mentioned otherwise.

L: Paid employment in the manufacturing sector in thousand man years, interpolated. Burgess (1993) takes the actual number of employed as a measure of labour demand. Unfortunately, for the Netherlands this series is only available from 1978 on. Because we study data of the manufacturing sector, and part-time jobs are rare in manufacturing, our measure of employment in labour years seems to be a good proxy for the actual number of employed (CBS, *Statistisch Jaarboek* 1990). Source: *L*, CBS, NA 1969–1984 and various issues, Table D12.

K: Real value of the capital stock of the manufacturing sector, interpolated. The nominal capital stock *CS* is calculated as

$$CS_t = CS_{t-1} - D_{t-1} + I_{t-1} \quad (B1)$$

where *D* is the depreciation and *I* is the investment in manufacturing. To yield *K*, *CS* is deflated by the real price of capital, defined by deflating the price index of investment goods (P_{inv}) by the producers price index of finished products (P_y).

Source: *CS*, CBS, *Kapitaalgoederenvoorraad* 1989, 1990, 1991. Other values calculated recursively using (A1);

D, CBS, NA 1969–1984 and various issues, Table D10;

I, CBS, NA 1969–1984 and various issues, Table D14;

P_{inv} , OECD, MEI (1980 = 100);

P_y , OECD, MEI (1980 = 100).

W: the real wage cost, interpolated. It is defined as

$$W = WI[(1 - WT/44.2) \times 1.3 + WT/44.2]$$

deflated by P_y , where *WI* is the wage rate in the manufacturing sector, *WT* is average working time. *W* takes account of the reduction in working time and allows for an overtime premium of 30%. Source: *WI*, CBS, *Statistisch Jaarboek*, various issues;

WT, CBS, *Statistisch Jaarboek*, various issues.

COMP: measure of domestic competitiveness. *COMP* is calculated as

$$COMP = \log(e \times P^*/P_y)$$

where $e \times P^*$ is the unit value index of world manufacturing exports converted from US dollars to Dutch guilders relative to the output price index P_y ; *e* is the spot exchange rate from US dollars to Dutch guilders.

Source: P^* , UN, MBS, various issues, special Table C or E;

e, OECD, MEI.

WT: world trade measure. *WT* is defined as the residuals of the following regression

$$\log(QW)_t = 3.934 + 0.0234t - 0.0003t^2 + 2.4E \\ (224.1) \quad (14.17) \quad (-6.631) \quad (6.561) \\ - 0.6t^3 + \text{seasonals.}$$

QW is the quantity index of exports of all commodities from world economies.

Source: *QW*, UN, MBS, various issues, special Tables C or E.

AD: adjusted fiscal deficit, interpolated. *AD* is defined as in Nickell (1986)

$$AD = GOVDEF/POTGDP - 0.39 \\ \times [(ICOST\ GOVDBT/POTGDP) \\ - 0.02 \times (GOVDEBT/POTGDP)],$$

where *GOVDEF* is government deficit, (*ICOST*) *GOVDBT* is the (interest payment of) government debts and *POTGDP* is the potential GDP, which we define as

$$POTGDP = GDP/CAPUT$$

where *GDP* is the actual GDP and *CAPUT* is the capacity utilization rate.

Source: *GOVDEF*, CBS, NA, Table R5;

GOVDEBT, CBS, *Statistisch Jaarboek*, various issues;

(*ICOST*) *GOVDEBT*, CBS, *Statistisch Jaarboek*, various issues;

GDP, CBS, NA 1969–1984 and various issues, Table M3;

CAPUT, OECD, MEI, various issues.

TP: measure of labour augmenting technical progress, interpolated. *TP* is computed via

$$\Delta_1 \log A_t = [\Delta_1 \log Y_t - v_1 \Delta_1 \log L_t \\ - (1 - v_1) \Delta_1 \log K_t] / v_1$$

where Y_t is the GDP of the industrial sector and v_1 is the labour income share. The initial value of the $\log A$ is set equal to zero. $TP = \log A$, smoothed by double exponential smoothing.

Source: *Y*, CBB, NA, Table M3;

v_1 , CPB, *Lange Reeksen*.

JJ: job-to-job, rate, defined as the number of job-movers per 100 workers. This series is composed of the

labour mobility measure, as collected by the CBS, *Arbeidskrachtentelling*, for 1975, 1977, 1979, 1981, 1983 and 1985, where the intermediate values were obtained by interpolation, the number of job-movers per 100 workers, as collected by the Dutch Ministry of Social Affairs and Employment in *Kwartaalbericht Arbeidsmarkt* 1992: 2 for the years 1983 to 1990. This series serves as the basis for the quit rate that we apply. The years 1972, 1973 and 1974 of *JJ* are based on a backward extrapolation of a regression of the yearly job-to-job mobility rate on lagged job-to-job mobility, the number of unemployed (U) and vacancies (V); V is the number of job vacancies in thousand units, and U is the seasonally adjusted unemployment in 1000 persons. Quarterly figures of *JJ* were obtained by interpolation, where account is being taken of the fact that the sum of these quarterly figures must equal the corresponding yearly quit rate. We do not approximate job-to-job movement by the vacancies-unemployment ratio ($V-U$) (cf. Burgess, 1988) because since the early 1980s the yearly figures of the job-to-job mobility rate and the corresponding $V-U$ do no longer resemble; job-to-job movement rose much steeper than $V-U$.

Source: V , OECD, *MEI*; U , OECD, *MEI*

F^x : number of persons moving from employment to unemployment and non-participation, where the latter consists of disability and (early) retirement. Quarterly fires are constructed by interpolation, taking account of the restriction that the sum of quarterly figures equals the corresponding annual figure.

Source: F^x , Sociale verzekeringsraad, *Kroniek van de sociale verzekeringen* 1992.

F^i : total inflow of new workers, calculated as $F_t^i = \Delta_1 L_t^{\text{tot}} + F_t^x$ where employment is the total number of workers in 1000 persons in the Netherlands. Quarterly inflow is constructed by interpolation in the same way as the outflow.

Source: L^{tot} OECD, *Labour Force Statistics*.

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